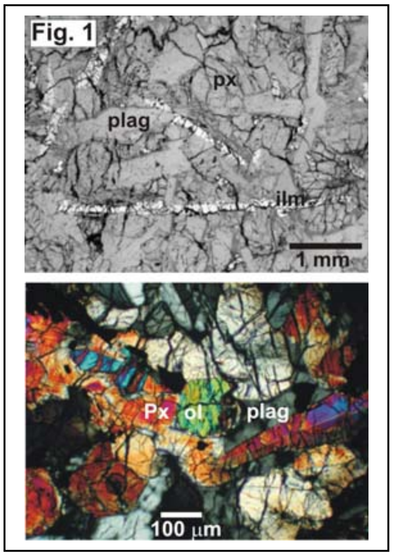
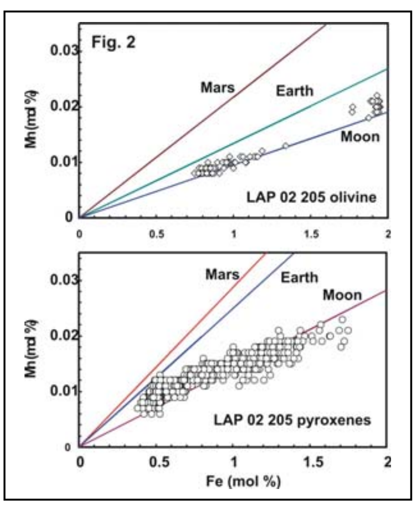
PETROLOGY AND GEOCHEMISTRY OF LAP 02 205: A NEW LOW-TI MARE-BASALT METEORITE

M. Anand[1] (anandm@utk.edu), L. A. Taylor[1], C. Neal[2], A. Patchen[1] and G. Kramer[2]; [1]Planetary Geosci. Inst., Univ. of Tennessee, Knoxville-37996, [2]Department of Civil Eng. & Geological Sci., Univ. of Notre Dame, IN 46556

LAP 02 205 is a low-Ti mare-basalt meteorite which was discovered in LaPaz Ice Field in Antarctica [1]. This is the first crystalline lunar basalt in US Antarctic collection and only the 8th mare-basaltic meteorite to be discovered on the Earth to date. We were allocated one thin section (LAP 02 205,36), one polished thick section (LAP 02 205,31), and 1.572 g powdered rock sample (LAP 02 205,19) by the Meteorite Working Group (MWG) for carrying out mineral and geochemical investigations.



Petrography and Mineral Chemistry: The rock displays holocrystalline texture (Fig. 1) consisting mainly of tabular pyroxene (0.5-1 mm long) and plagioclase laths (up to 1 mm long), with rare olivine grains (up to 0.5 mm). Accessory minerals include ilmenite, chromite, ulvöspinel, troilite, FeNi metal, and abundant free silica, most likely tridymite. This rock is also rich in late-stage mesostasis that is composed largely of fayalite and K-rich-glass. Shock effects are evident in terms of extensive cracks through mineral grains, adulatory extinction in plagioclase and pyroxene, and shock-melt veins and pockets. Pyroxenes also display shock induced twinning in some cases. Fe to Mn ratios in pyroxene and olivine (Fig. 2, after [2]), presence of FeNi metal, and oxygen isotopic compositions [1] are some of the pieces of evidence for lunar parentage for this rock. In appearance, this is a low-Ti mare basalt, with similarities to some pyroxene-phyric Apollo 15 basalts such as 15075 [3]. Cooling-rate estimations [4] based on width of the plagioclase laths yield values of 2 °C/day for the lava.

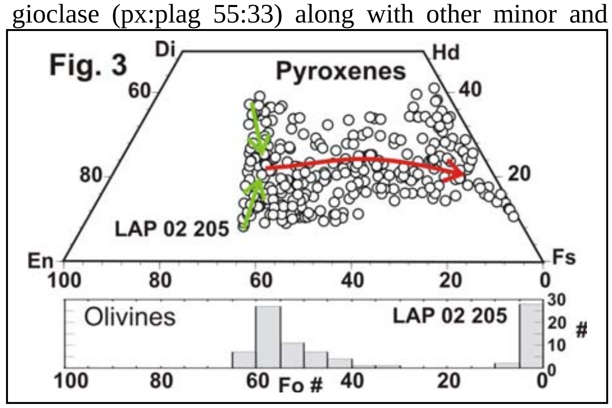


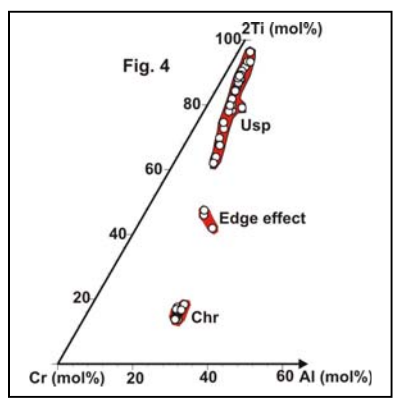
The modal mineralogy of LAP 02 205, as determined by EMP mapping [5], is given in Table 1.

Table 1: Mineral modes (219,238 points)

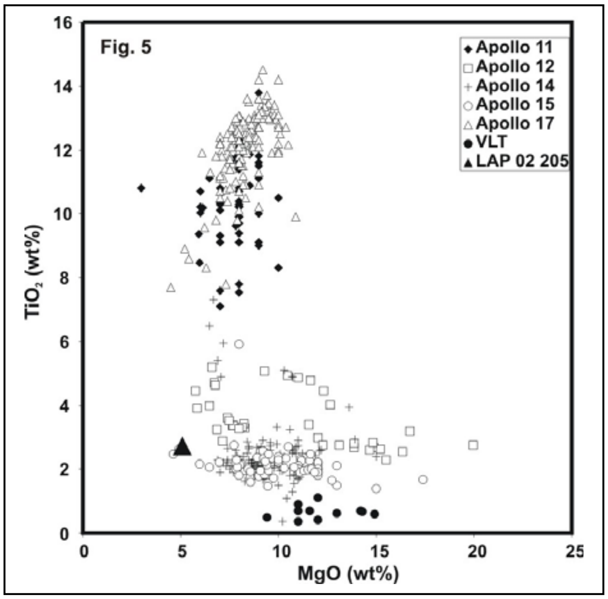
Phases	LAP 02 205,36
Plagioclase	33.06
Pigeonite	11.99
Fe-pyroxene	15.86
Augite	29.04
Olivine	1.19
Silica	2.3
Ilmenite	3.33
Ulvöspinel	0.42
Chromite	0.08
Troilite/FeNi metal	0.16
Fayalite	1.53
Phosphate	0.27
K-glass	0.79
Total	**100.02**

Essentially, this sample consists of pyroxene and plagioclase (px:plag 55:33) along with other minor and accessory minerals. Many pyroxene grains show asymmetrical chemical zoning with extreme iron enrichment all the way to pyroxferroite. Pyroxene compositions show extreme variation in chemistry following a typical mare-basalt fractionation trend (Fig. 3). The highest Fo content measured in an olivine grain is 62, with the majority of olivine analyses within the ranges of Fo 40 to 62 and Fo 0 to 10, indicating the fractionated nature of this

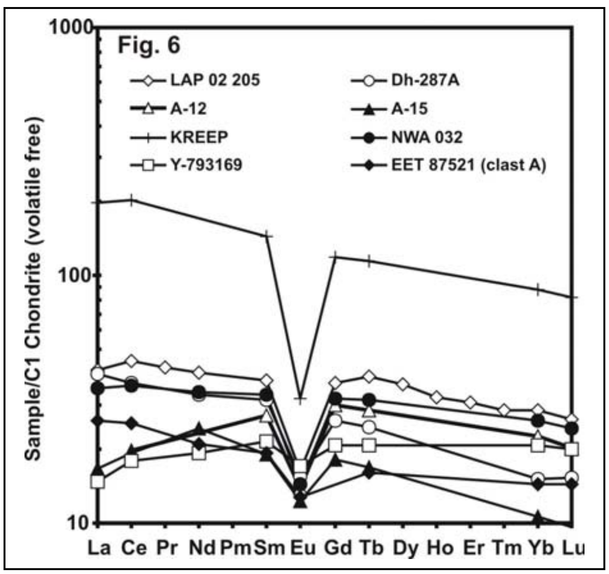




basalt. Plagioclase compositions mainly vary from An



84 to 90 with a few grains with values between An 82 to 84. LAP 02 205 also contains higher abundances (~3%) of late-stage mesostasis, which is distributed



evenly throughout the sample. Opaque minerals are abundant (~4%) in LAP 02 205. Ilmenite is most common (as lath-shaped grains) followed by spinels (chromite and ulvöspinel). The MgO content in ilmenite varies from < 0.03 to 2.35 wt%, with an average value of < 0.2 wt%. Similarly, ZrO_2 content in ilmenites varies from < 0.03 to 0.76 wt%, with an average value of 0.2 wt%. Among spinels, ulvöspinels are more common than chromite in this sample. ZrO_2 content in ulvöspinel varies from < 0.03 to 0.2 wt%, with an average value of < 0.1 wt%. Ilmenite and the spinels are only rarely in contact. LAP 02 205 spinels show fractionation trends similar to those of low-Ti mare basalts (Fig. 4, after [3]). FeNi metals show variation in their Ni and Co contents depending upon the associated silicate phase. In the FeNi metals, the Ni content varies from 5.3 to 16 wt% whereas Co content varies from 1.3 to 3.4 wt%.

Bulk-rock Major- and Trace-element chemistry: The whole-rock, major- and trace-element compositions of LAP 02 205 were determined on 50 mg powdered rock sample using solution ICP-MS following the procedure of [6]. In terms of major elements (5.1 wt% MgO, 2.72 wt% TiO_2), LAP 02 205 is a low Ti, highly fractionated, mare basalt, similar to some A-15 samples (Fig. 5). In terms of REE contents, LAP 02 205 has the highest chondrite-normalized REE pattern (Fig. 6, after [7]), among all known mare-basalt meteorites. This feature, combined with lower abundances of compatible-element concentration (Table 2) suggests a highly fractionated nature of the melt from which this rock was derived.

Table2: Major- and Trace-elements in LAP 02 205,19

Majors	wt%	Traces	ppm	REEs	ppm
SiO_2*	53.7	Li	11.7	La	13.63
TiO_2	2.72	Be	1.37	Ce	36.52
Al_2O_3	8.95	Sc	58.6	Pr	5.14
FeO	18.67	V	129.0	Nd	24.97
MnO	0.23	Co	37.3	Sm	7.48
MgO	5.10	Ni	27.60	Eu	1.36
CaO	10.08	Rb	2.11	Gd	10.18
Na_2O	0.33	Sr	135.3	Tb	1.92
K_2O	0.09	Y	73.16	Dy	11.80
P_2O_5	0.13	Zr	200.3	Ho	2.43
Total	100.0	Nb	14.7	Er	6.73
		Cs	0.10	Tm	0.90
		Ba	164.7	Yb	6.54
		Ta	0.77	Lu	0.90
		W	0.20		
		Pb	1.00		
		Hf	5.39		
		Th	2.33		
		U	0.55		

* SiO_2 is calculated by difference.

Summary: LAP 02 205 is a low-Ti mare basalt meteorite that has distinct mineral and geochemical characteristics. It is an olivine-bearing rock that crystallized relatively slowly, thereby permitting development of a range in mineral compositions, also reflected by its texture. It contains an abundance of late-stage mesostasis that, along with the whole-rock compositions, confirms the highly fractionated nature of LAP 02 205 parental melt, albeit not KREEP-enriched, evident by low-MgO.

References: [1] Ant. Met. News Lett. (2003), 26(2); [2] Papike et al. (2003) Am. Min., 88, 469-472; [3] Taylor & Misra (1975) 6th PLSC, 165-179; [4] Grove & Walker (1977) 8th PLSC, 1501-1520; [5] Taylor et al. (1996) Icarus, 124, 500-512; [6] Neal (2001) JGR, 106, 27865-27885. [7] Anand et al. (2003) MAPS 38, 485-499.